

VISUALIZING INFORMATION

ISAT Study 1997: Woods Hole Presentation

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Right Picture In Right Mind At Right Time

- ζ Visualization Is Happening**
- ζ Visualization Will Directly Control Weapons**
- ζ Seeing Is Believing: Misuse Is Life Threatening**
- ζ New Visualization Paradigm Needed To Safely and Effectively Convey and Control The Battlespace**

We live in an age that is driven by information...changing the face of war and how we prepare for it - William Perry

Overview

ζ **What Do We Mean By A New Visualization Paradigm**

Key Change: Visualizations Become The Interface And Medium Of
Coordination

Two Scenarios As Examples

ζ **Current Technological Opportunities**

ζ **Technological Roadblocks**

ζ **Research Strategies**

Command Centers

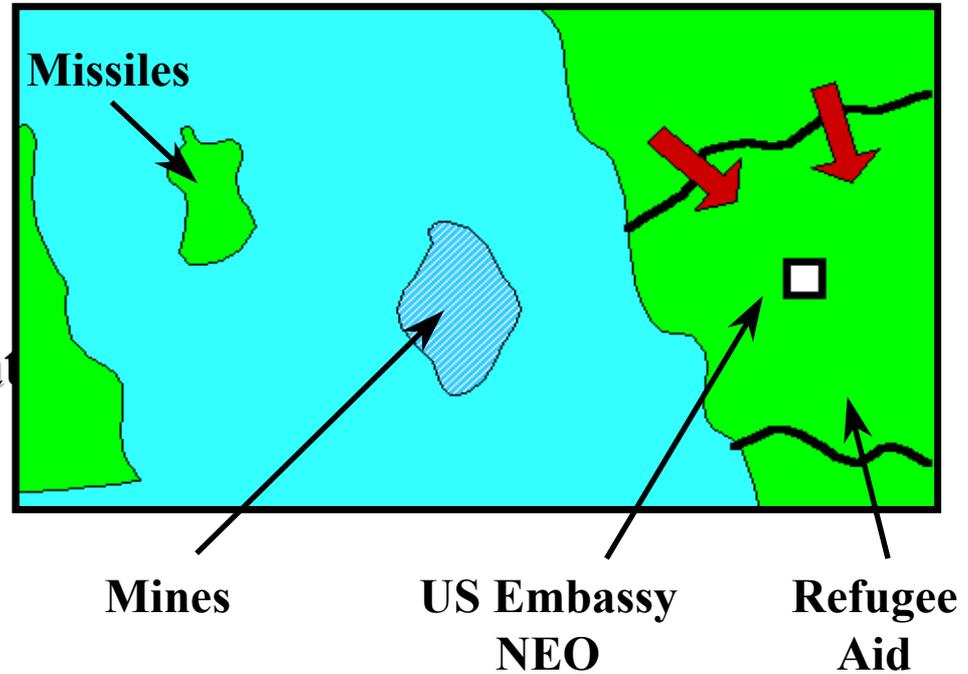
§ Contingency Team

Multi-service

Multi-language

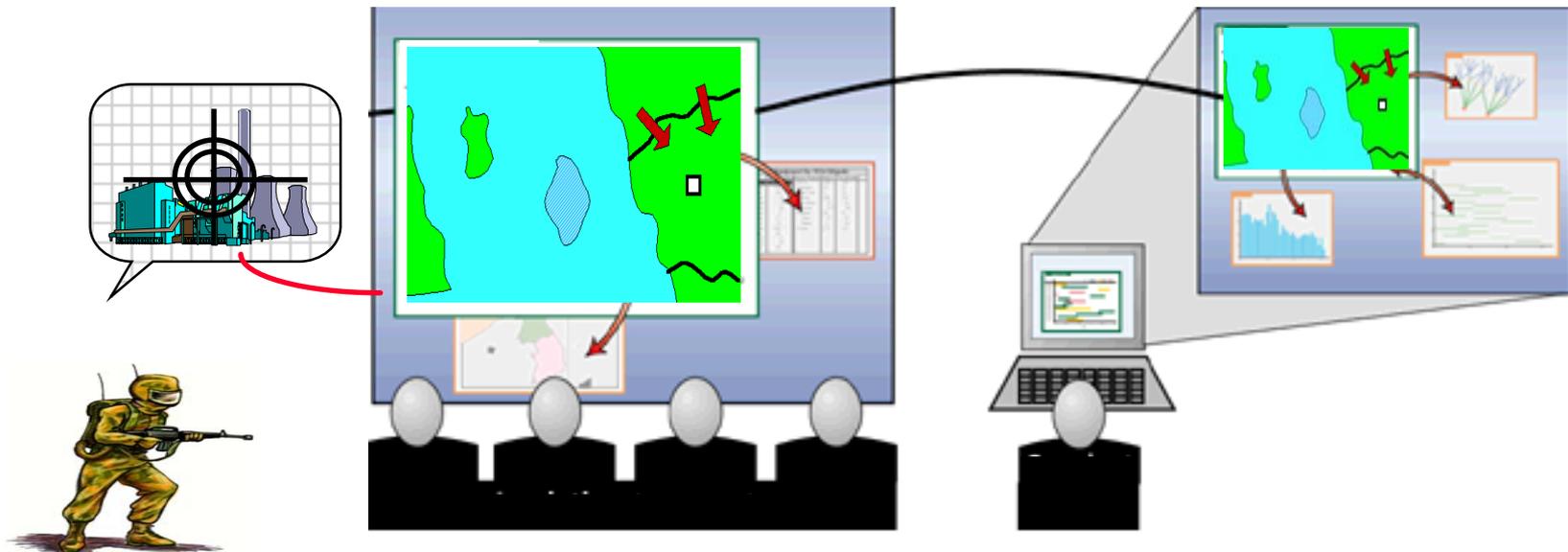
Multi-cultural

§ Flood Of Incoming Data

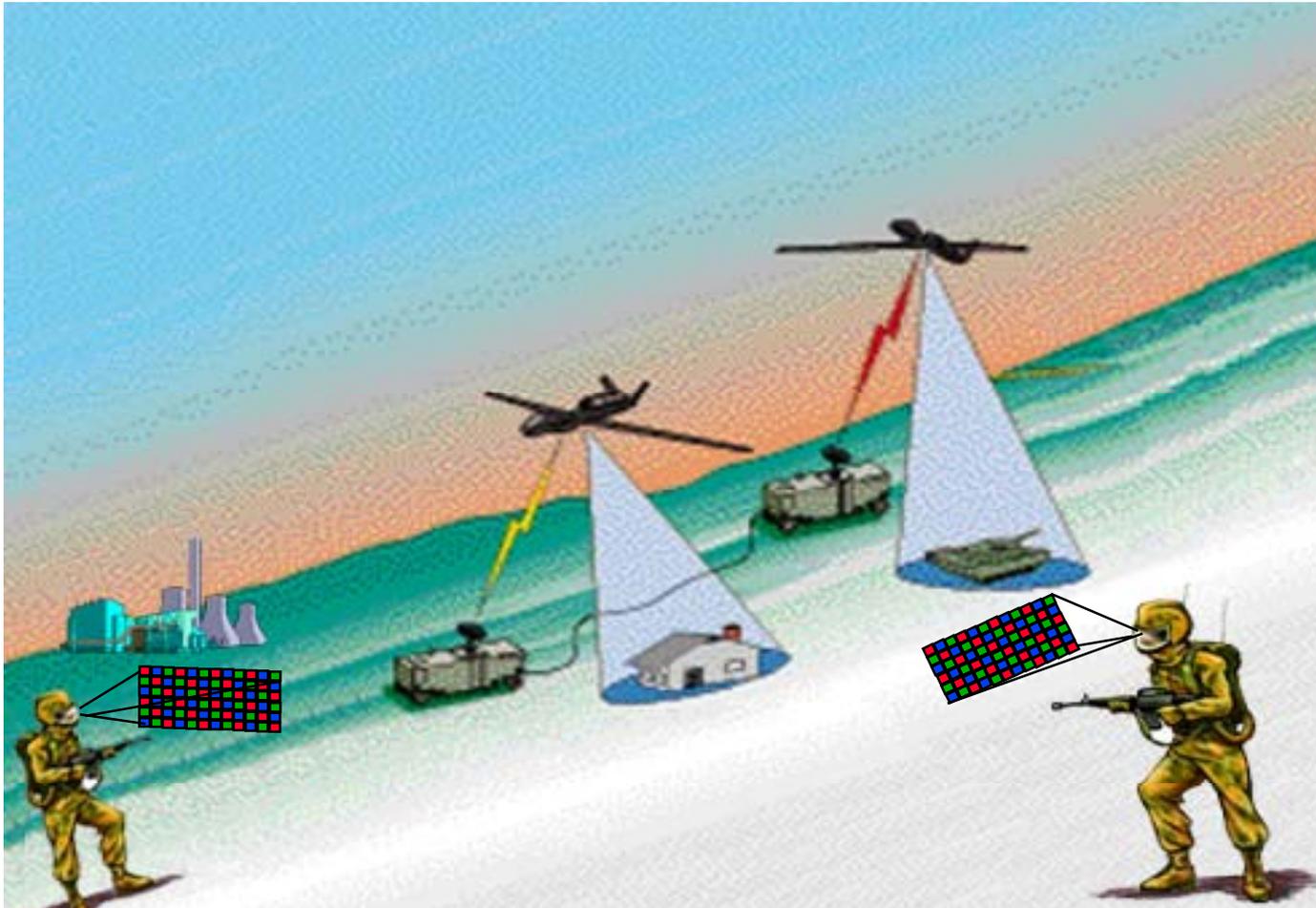


Visualization Needs

- ζ Accuracy = WYSIWIM
- ζ Unambiguous Expression of *Intent* = WYSIWYD
- ζ Common View Communicated Up & Down The Hierarchy



Individual Warfighter



Individual Warefighter

SOCOM Combat Management System



ETO/URBAN

GPS Module

- Antenna
- Rockwell PLGR GPS Engine
- Size 4.5" x 3" x 1"

CPU Module

- 133MHz Pentium CPU
- 64MB DRAM
- 2 GB Hard Drive
- 2 PCMCIA Slots
- 2 RS-232 Ports
- Universal Serial Bus
- Size 6" x 7.25" x 1.25"
- Weight 10.78 Lbs. (est)



Wireless LAN

- Proxim RangeLAN2
- 1.6 Mbps data rate
- Range 1000 ft. LOS
- 2.4 - 2.4835 GHz Spread Spectrum

Battery on Back

- Solid Lithium Ion Polymer
- 9.6 Amp Hour
- System Operation at Least 6 Hrs

MXF-610 Radio

- Computer Control
- Voice
- Data (16Kbps)
- Range > 5KM

Visualization Needs of Warfighter

- ζ **Represent Information Efficiently**
- ζ **Customize Information To Individual Soldier Needs And Situation**
- ζ **Scale To Large Number of Soldiers**
- ζ **Meet Time Critical Requirements**
- ζ **Maintain Military Quality of Service**
 - Select Most Effective Modality: Text, Image, Animation, Voice, Touch
 - Graceful Degradation

Roadblocks

- ζ **Many Visualization Techniques Don't Scale**
- ζ **Not Adapted To Distributed Networked Environment**
- ζ **Don't Convey Data Confidence Or Trust**
- ζ **Batch Mode: Move From Data To Visualization**
- ζ **Difficult To Shift Between Different Levels of Abstraction**
 - From One Perspective To Another
 - From Views Appropriate To One Task To Those Appropriate To Another
- ζ **Effective Visualization Often Require Visualization Experts**
- ζ **Being Pursued Piecemeal With Pre-Paradigm Shift Software**

Why Now

ζ **Massive Amounts Of Data Are Available**

Sensors

Modeling

ζ **Exciting Advancements In Hardware Technology**

Fast Inexpensive Graphics Hardware

Faster Than Moore's Law (Factor of 10 in 3 years; Exploit Parallelism and special HW)

New Sensors and Displays

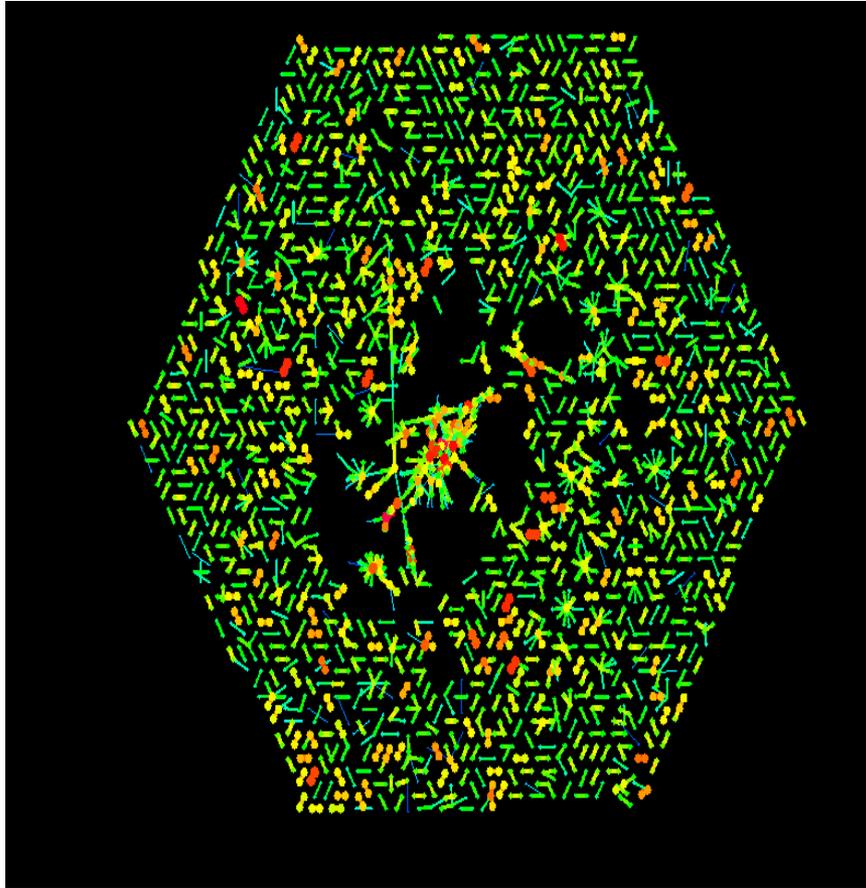
Computing, Networking, and Storage

ζ **Significant Developments In Interactive Visualization**

New Visual Metaphors For Abstract Information Applicable To Networks, Software

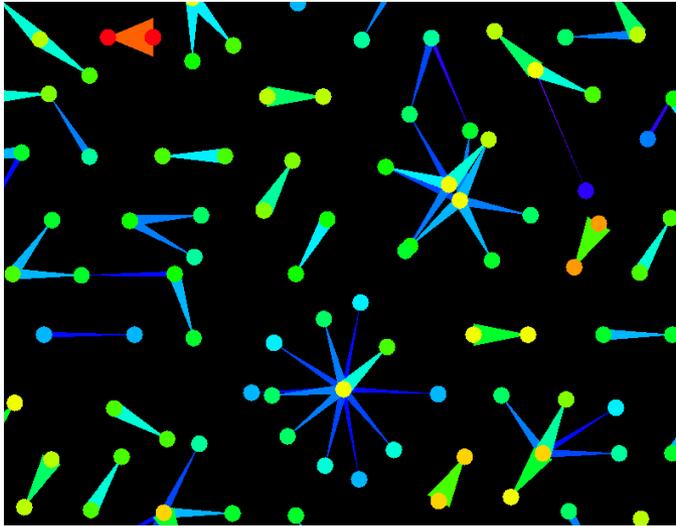
Visual Workspaces

Detecting Patterns

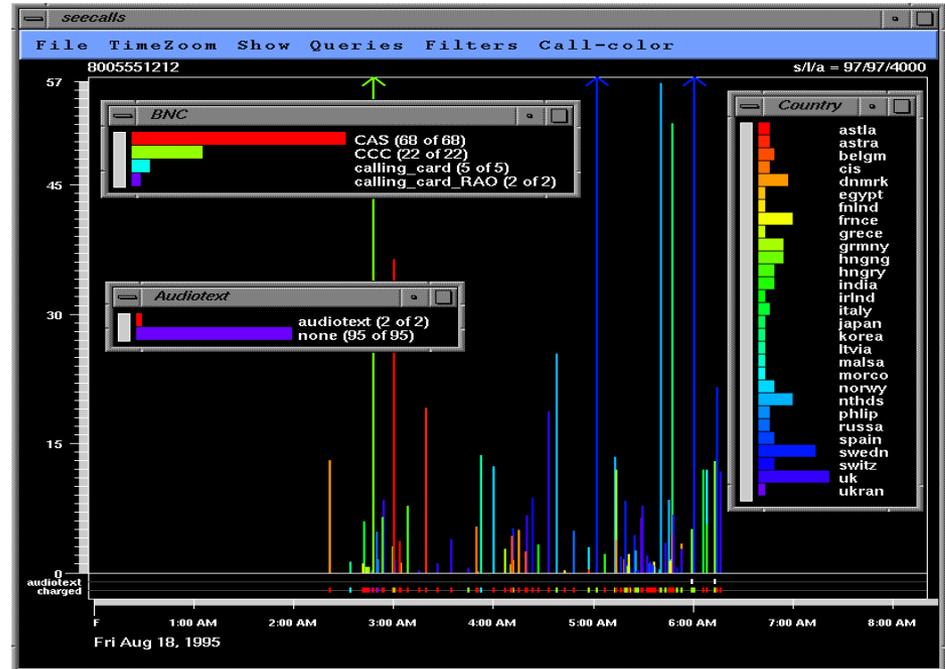


Application: Phone Fraud
Consequences:
Industry Loses Of
Billions/Year

Detecting Patterns



**Result For Unnamed
Long Distance Company:
Something Like Eight
Figure Savings**



Assess Situation

SEESOFT
OPERATIONS COLORBAR VIEW OPTIONS HELP

f6x030c.cob

DX
DC
DO
Other

values 3/1
lines 1556/1970
files 1/1

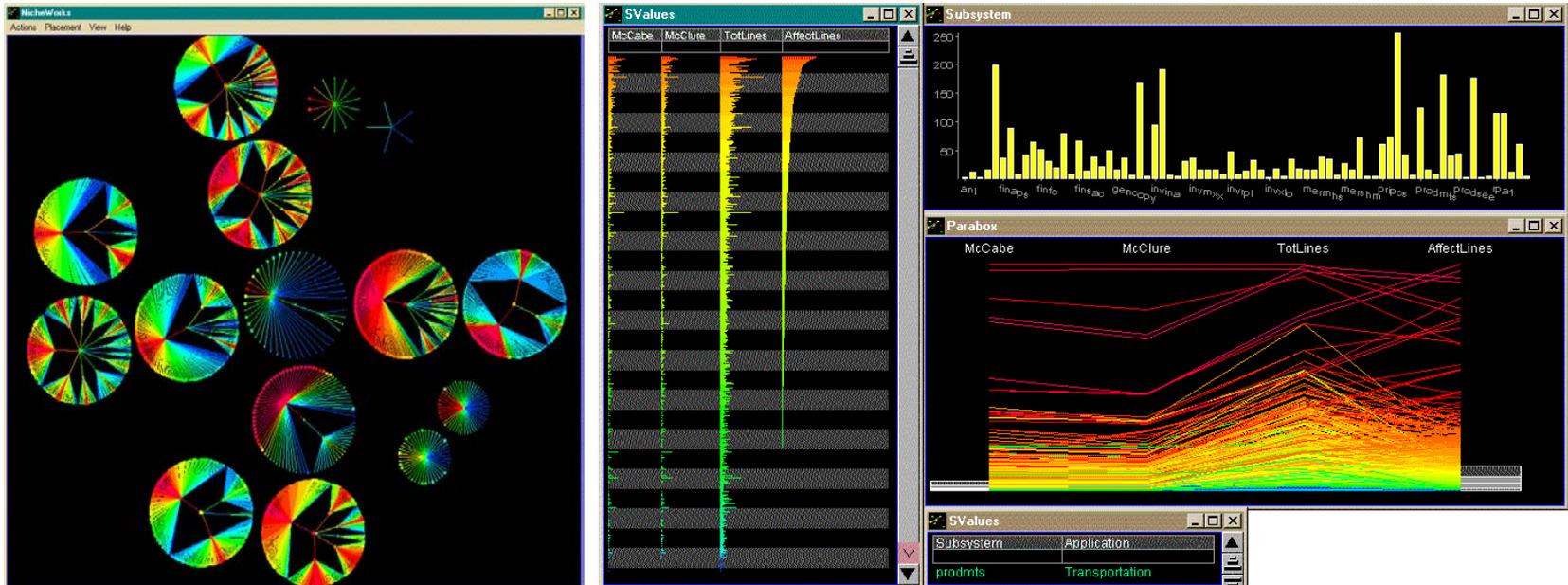
F6X030.COB, LINE 8831 OF 19708

```
437450 PERFORM J551-REPLACE-BEG-DATE-LITERAL. F6X030
437500 SKIP1 F6X030
437550 IF ITEM-01-TAX-AN-BEG-DEPR-DATE EQUAL TO SPACES-04 F6X030
437600 AND CCR-ACCOUNTING-CYCLE NOT EQUAL TO '1' F6X030
437650 MOVE ORG-CODE-BAS TO ORG-FLG-TAX-BEG-DATE F6X030
437700 MOVE ITEM-00-BASE-AN-BEG-DEPR-DATE F6X030
437750 TO ITEM-01-TAX-AN-BEG-DEPR-DATE. F6X030
437800 SKIP1 F6X030
437900 OR ITEM-01-TAX-A-B-CODE EQUAL TO 'C' F6X030
```

Problem:
Year 2K
Application:
Identifying
Necessary
Code Changes

Heralded As:
600 Billion
Dollar
Problem

Prioritize Tasks



Result: 40-80% Improvement In Identifying Code Needing Changes

Themes From Successful Efforts

- ζ **Visualization Supports Problem Solving and Encourages Collaboration**
- ζ **Multiple Task-Specific Views Show Different Perspectives**
 - Often Novel Views To Show Overviews and Details
 - Views Focus and Filter To Match Different Tasks Needs
- ζ **Interactive Views Function As Environments**
 - Operations Are Fast, Intuitive, and Reversible
 - Linked Views with Brushing Support Drill Down, and Aggregation
 - Movement Between Views That Preserves Context
- ζ **Visualizations Connected To Analysis Engines With Effective Algorithms Allow Scaling To Real Domains**

Research Goal

Coherent Framework for Visualization Research Addressing Full Information Requirements of the Military

1 Move From Visual Workspace To Visual Decision Space

Visualizations To Convey And Control The Battlespace

2 Understand How To Create Visual Metaphors

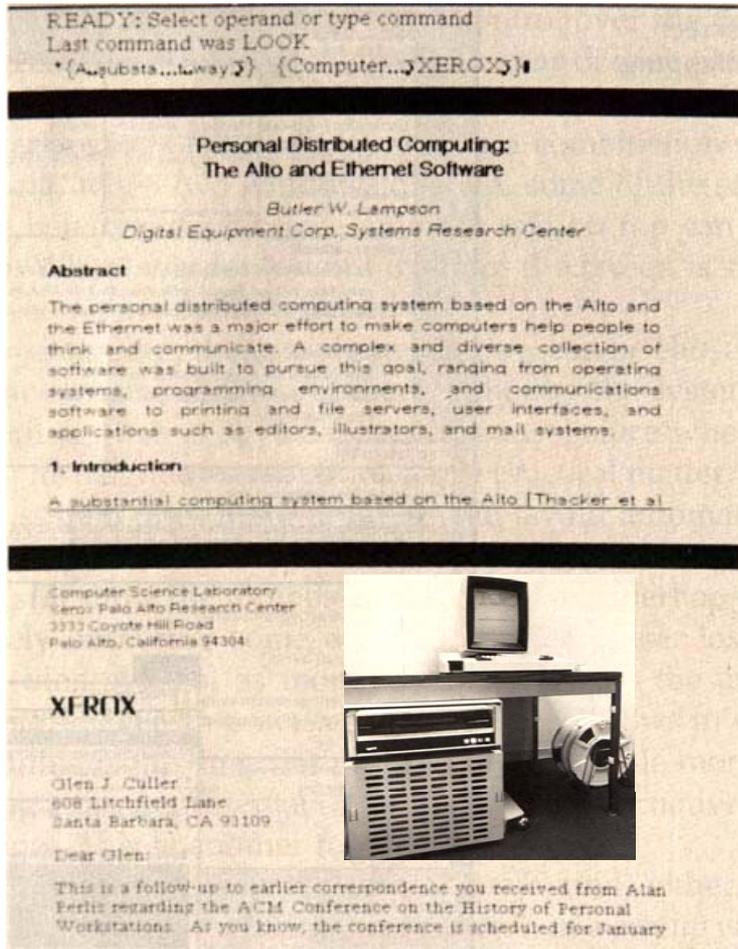
Understand Principles For Creating Effective Visual Metaphors And
Visualizations

Design Effective Integrated Visualizations For Military Applications

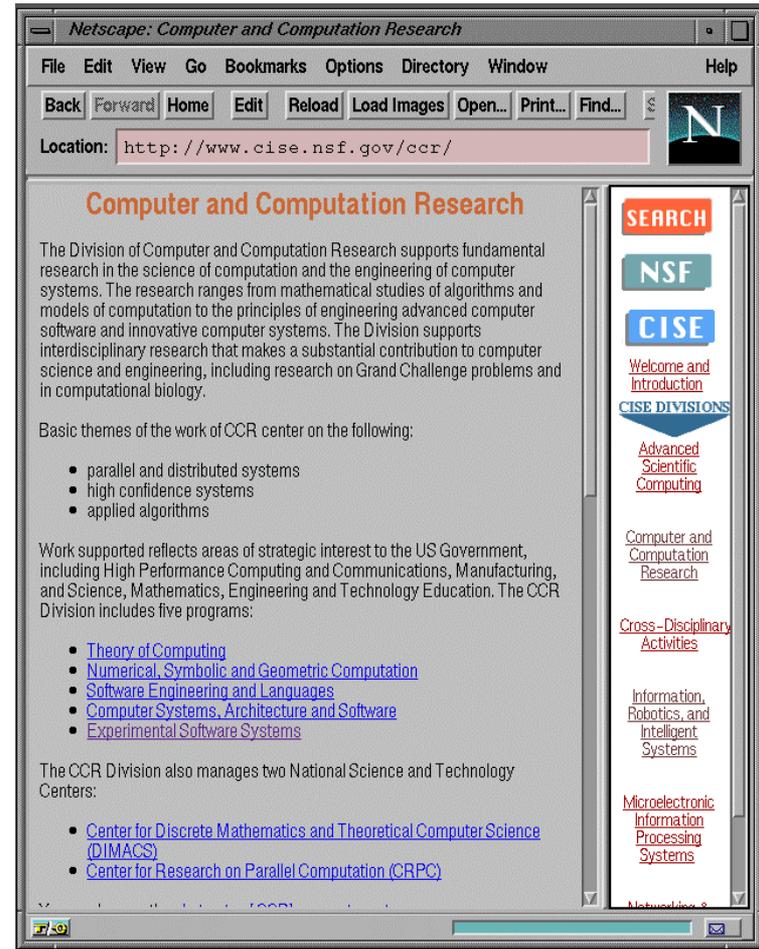
3 Develop A Production Technology

Support Engineering By Domain Experts

Visual Workspace



Xerox Alto 1970's



Netscape 1990's

Visual Decision Space

Visual Workspace To Visual Decision Space

ζ Gap

Supporting Individual To Supporting Coordinated Teams

Natural Visualizations Of Battlespace

Linked Across Multiple Resolutions

For Different Command Levels

ζ Approach

Direct Control Via

Visualizations Themselves



Visual Metaphor Methodology

Visual Metaphors To Methodology For Production

ζ Gap

Effective and Reliable Metaphors
General Methodology

ζ Approach

Mine The Past

Tufte

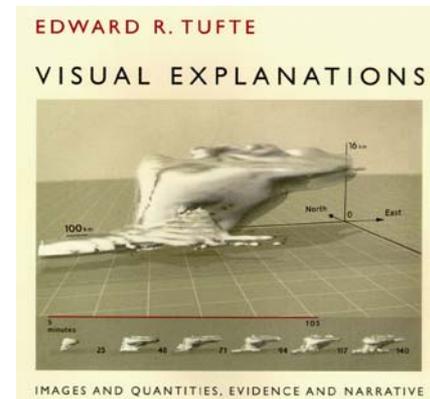
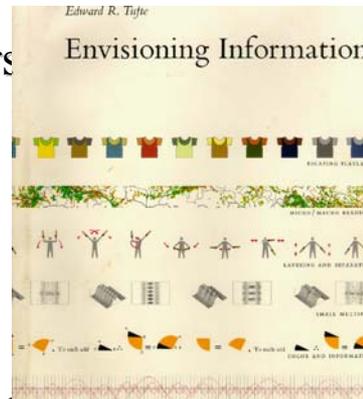
Exploit Existing Military Metaphors

Ground In Principles About Semantics and Perception of Graphics

Advance Automating Design of Graphics

APT, Mackinlay

Visage, Roth



Visualization Production Technology

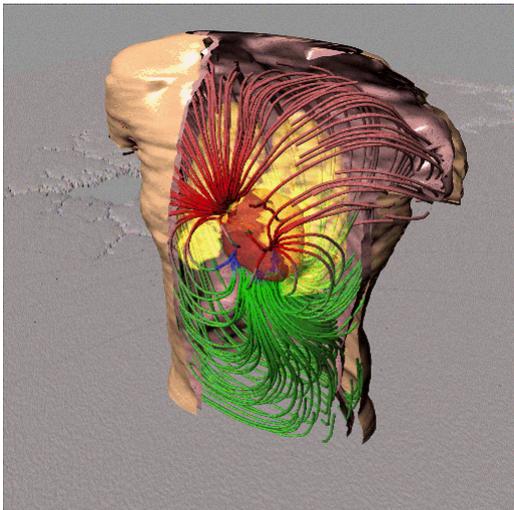
ζ Current State: Point Solutions

Different Visualizations: GIS SciVis SeeNet SeeSoft ...

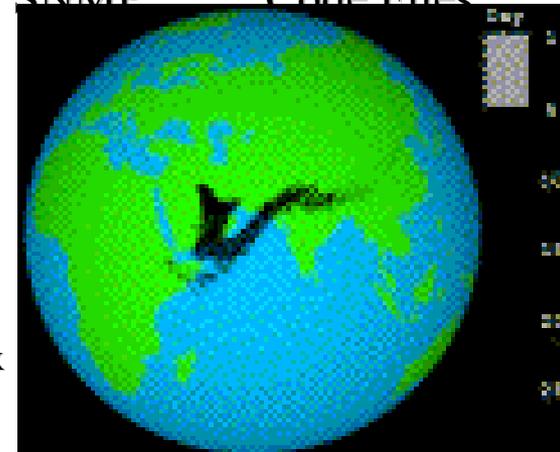
Different Visual Models: Spatial Scalar Networks Document
Processing

Different Data:

Vector Statistical
Geographic Sim SNMP Code Files
Satellite
Sensors



3D Vector Field Visualization
of Electric Field within Thorax
*Johnson, Macleod, Matheson
Utah*



Simulated Kuwaiti Oil Fire from
Gulf War, *AdvancedComputing*

Visualization Production Technology

Point Solutions To Integrated Framework

ζ Gap

Connecting Between Types Of Visual Models And Data Types

Example: GIS Integrated With Network Visualization

Developers Need Mix and Match To Best Meet Military Task Requirements

Integrated Multilevel Representations Across Multi-Resolution Information, Sensor, and Engagement Grids

ζ Approach

Model Specific Languages Connected Via Meta-Languages For Visual Models

Multiscale Visualization Tools

Pad++

Toolkits With Increased Automation: Visualization Builder

VTK, SCIRun, APT, SageBrush

Summary

Right Picture In Right Mind At Right Time

ζ **Current Situation**

Visualization Is Happening

Visualization Will Directly Control Weapons

Misuse Is Life Threatening: Seeing Is Believing

Imperative We Understand Creation Of Effective Visualizations

ζ **Opportunity**

Massive Data Available From Sensing, Modeling, Network

Dramatic Increase In High Performance Graphics Performance

Existence Proofs For Interactive Information Visualization Effectiveness

ζ **Strategy**

Move From Visual Workplaces To Visual Decision Spaces

Exploit Visual Metaphors: Representation Becomes The Interface

Develop Production Technology For Military Visualizations

ζ **Impact**

Safe and Effective Control Of The Battlespace

Study Participants

Chair: Jim Hollan (UCSD)

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Anis Husain (ETO)

Hiroshi Ishii (MIT)

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